Solution to Exercise 4.8.4

The result is most easily found in the spectrum's formula: the power in the signal-related part of *x (t)* is half the power of the signal *s (t)*.

Solution to Exercise 4.9.1

The inverse transform of the frequency response is

$$\frac{1}{RC}e^{-\left(\frac{t}{RC}\right)}u(t).$$

Multiplying the frequency response by

$$1-e^{-(j2\pi f\triangle)}$$

means subtract from the original signal its time-delayed version. response's time-domain version by Δ results in RC eu (t − Δ). Delaying the frequency resonse’s time-domain version byΔ results in

$$\frac{1}{RC}e^{\frac{-(t-\triangle)}{RC}}u(t-\triangle).$$

Subtracting from the undelayed signal

$$\frac{1}{RC}e^{\frac{-t}{RC}}u(t)-\frac{1}{RC}e^{\frac{-(t-\triangle)}{RC}}u(t-\triangle).$$

Now we integrate this sum. Because the integral of a sum equals the sum of the component integrals (integration is linear), we can consider each separately. Because integration and signal-delay are linear, the integral of a delayed signal equals the delayed version of the integral. The integral is provided in the example.

Solution to Exercise 4.10.1

If the glottis were linear, a constant input (a zero-frequency sinusoid) should yield a constant output. The periodic output indicates nonlinear behavior.

Solution to Exercise 4.10.2

In the bottom-left panel, the period is about 0.009 s, which equals a frequency of 111 Hz. The bottom-right panel has a period of about 0.0065 s, a frequency of 154 Hz.

Solution to Exercise 4.10.3

Because males have a lower pitch frequency, the spacing between spectral lines is smaller. This closer spacing more accurately reveals the formant structure. Doubling the pitch frequency to 300 Hz for Figure 4.16 (voice spectrum) would amount to removing every other spectral line.